Industrial Sulphur Emissions for Alberta 1977-1981

Alberta
ENVIRONMENT
Pollution Control
Division

INDUSTRIAL SULPHUR EMISSIONS

FOR ALBERTA 1977-81

prepared by

ALBERTA ENVIRONMENT

POLLUTION CONTROL DIVISION

AIR QUALITY CONTROL BRANCH

September, 1982
Edmonton, Alberta

EXECUTIVE SUMMARY

This report provides the sulphur (sulphur dioxide expressed as sulphur) emissions inventory from industrial sources operating in Alberta for the period 1977-81. The sulphur emissions inventory is provided for industrial sources such as sour gas plants, sour oil production facilities, oil sands plants, coal fired power plants, refineries, fertilizer plants, pulp an paper mills, and heavy oil recovery plants.

Annual sulphur emissions for individual plants contributing to the observed (actual) and licenced emissions of each industrial grouping are presented on a year-to-year basis. Trends of both observed and licenced sulphur emission inventory totals are also provided.

On the basis of industrial groupings, coal fired power plants have had an increase in sulphur emissions over the period 1977-81. During this same period the sour gas industry has shown a decrease. The sour oil production facilities have been included in the inventory since 1978, and have shown a consistent decrease as more sour oil pools have been included in gas conservation schemes.

Generally, total observed sulphur emissions have remained well below total licenced emissions. In 1981 the actual observed emissions are approximately 52 percent of the licenced emissions compared with 54 percent over the total report period.

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I. INTRODUCTION

The Air Quality Control Branch of Alberta Environment undertook the task of updating the "Industrial Sulphur Emissions for Alberta 1974-1978" publication compiled in April, 1979 by the Research Secretariat, Division of Alberta Environment. This report provides the sulphur (sulphur dioxide expressed as sulphur) emissions from various industries operating in Alberta for the period 1977-1981. The data are as accurate and precise as possible given the information available.

The report provides two types of inventories: a) licenced maximum sulphur emissions from industrial sources as specified by the Clean Air Licence to Operate or Use for the specific plants; and b) observed or actual sulphur emissions from industrial sources in Alberta. The observed emissions are obtained from monthly reports from industry and/or from manual stack survey results. Deviations from this are noted in the tables.

These data are presented in two main sections: the first (Section II - Sulphur Emission in Various Industries) deals with the data for the period 1977-1981 on observed and licenced sulphur emissions for individual plants contributing to the emissions inventory for various industries; the second (Section III - Industrial Sulphur Emission Inventory) covers total observed and licenced sulphur emissions from industrial sources operating in Alberta for the period 1977-1981. Graphical representation of various trends are provided.

II. SULPHUR EMISSIONS IN VARIOUS INDUSTRIES

This section contains the data on observed and licenced sulphur emissions for individual plants contributing to the emissions inventory for various industries operating in Alberta for the period 1977-1981. The industrial source groupings consist of the following:

- Sour Gas (Extraction) Plants
- Sour Gas (Flaring) Plants
- Sour Oil Production Facilities
- Oil Sands Plants
- Coal Fired Power Plants
- Refineries
- Fertilizer Plants
- Pulp & Paper Mills
- Heavy Oil Recovery Plants

Tables 1 to 10 provide the breakdowns on a year-to-year basis of the sulphur emissions from the various plants contributing to the total inventory of that industry grouping.

Figure 1 illustrates the levels of the observed versus licenced sulphur emission totals for the more significant industrial sources over the past five years.

TABLE 1 : SULPHUR EMISSIONS (OBSERVED VS LICENCED IN TONNES/DAY) FROM GAS PROCESSING PLANTS WITH SULPHUR RECOVERY (EXTRACTION) OPERATING IN ALBERTA FOR THE PERIOD 1977-81.**

PLANT (OPERATOR)	1977	1978	1979	1980	1981
BALZAC-CROSSFIELD (Petrogas)	14.5 (44.4)	18.2 (44.4)	17.2 (44.4)	16.7 (44.4)	13.9(44.4)
BIGSTONE (Amoco)	6.6 (16.2)	9.6 (16.2)	10.4 (16.1)	9.8 (16.1)	8.0 (16.1)
BONNIE GLEN (Texaco)	0.1 (1.1)	0.1 (1.1)	1.4 (1.1)	0.4 (1.1)	0.3 (1.1)
BRAZEAU RIVER (Dome)	4.3 (8.5)	2.0 (8.5)	5.2 (8.5)	4.5 (9.5)	3.7 (9.5)
BRAZEAU RIVER-NORDEGG (Canterra Energy)	1.2 (4.1)	1.7 (4.6)	2.1 (4.6)	1.6 (4.6)	1.6 (4.6)
BURNT TIMBER (Shell)	12.2 (20.9)	16.9 (20.9)	14.2 (21.3)	16.6 (21.3)	15.5(21.3)
CAROLINE (Dome/H.B.O.G.)	0.5 (2.4)	1.4 (2.4)	1.2 (2.4)	1.4 (1.9)	0.7 (1.9)
CARSTAIRS-CROSSFIELD (Home Oil)	3.2 (8.0)	3.0 (8.0)	3.1 (8.0)	2.4 (7.2)	2.2 (7.2)
CROSSFIELD-EAST (Amoco)	26.2 (37.2)	32.9 (37.2)	29.4 (37.2)	35.9 (36.6)	25.3(36.6)
EDSON (Dome)	8.4 (20.1)	7.2 (20.1)	6.3 (20.1)	5.4 (20.1)	4.8 (20.1)
GOLD CREEK (Petro-Canada)	0.8 (3.2)	0.6 (3.2)	0.7 (3.2)	0.7 (3.2)	0.5 (3.2)
HARMATTAN ELKTON (Canadian Superior)	11.3 (25.7)	12.2 (25.7)	12.1 (25.7)	10.5 (25.7)	9.2 (25.7)

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TABLE 1 CONTINUED

PLANT (OPERATOR)	1977	1978	1979	1980	1981
HOMEGLEN-RIMBEY (Gulf)	12.5 (19.4)	11.2 (19.4)	11.4 (19.4)	9.8 (19.4)	7.8 (19.4)
INNISFAIL (Shell)	4.3 (9.4)	3.2 (9.4)	4.9 (9.3)	4.5 (9.3)	4.2 (9.3)
JOFFRE (Esso Resources)	2.1 (1.9)	2.0 (1.9)	1.5 (1.9)	1.6 (1.9)	1.0 (1.9)
JUMPING POUND (Shell)	16.0 (27.9)	17.4 (27.9)	17.8 (27.9)	18.0 (23.5)	19.9(23.5)
KAYBOB SOUTH #1 & 2 (Dome)	21.4 (44.3)	18.0 (44.3)	20.9 (44.3)	21.2 (44.3)	14.9(44.3)
KAYBOB SOUTH #3 (Chevron Standard)	43.5 (109.3)	41.4 (109.3)	32.5 (109.3)	30.2 (99.0)	29.6(99.0)
LONE PINE CREEK (Canadian Superior)	3.0 (8.1)	2.0 (8.1)	2.5 (8.1)	2.5 (8.1)	2.5 (8.1)
LONE PINE CREEK (Dome)	5.2 (11.9)	4.0 (11.9)	3.5 (11.9)	3.1 (11.8)	2.4 (11.8)
MINNEHIK-BUCK LAKE (Sulpetro)	0.6 (2.6)	0.4 (2.6)	0.7 (2.6)	0.5(2.6)	0.4 (2.6)
MORLEY (Pan Canadian)	N/O	N/O	N/O	0.1 (1.2)	0.2 (1.2)
NEVIS (Chevron Standard)	4.4 (6.4)	3.7 (6.4)	4.1 (6.4)	3.2 (6.4)	2.0 (6.4)
NEVIS (Gulf)	6.7 (13.9)	6.9 (13.9)	8.9 (13.9)	7.8 (13.9)	6.0 (13.9)
OKOTOKS (Canterra Energy)	16.1 (26.6)	12.2 (26.6)	11.3 (26.6)	14.1 (26.6)	13.1(26.6)

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TABLE 1 CONTINUED

PLANT (OPERATOR)	1977	1978	1979	1980	1981
OLDS (Amerada)	3.4 (20.6)	3.9 (20.6)	3.3 (20.6)	3.7 (20.6)	4.2 (20.6)
PADDLE RIVER (Canada-Cities Service)	x	x	x	x	0.5 (2.2)
PINCHER CREEK (Gulf)	4.5 (10.2)	5.0 (10.2)	3.6 (10.2)	3.5 (10.2)	2.8 (10.2)
QUIRK CREEK (Esso Resources)	6.8 (14.0)	4.1 (14.0)	6.7 (14.0)	4.8 (13.8)	6.1 (13.8)
RAINBOW LAKE (Canterra Energy)	6.2 (10.2)	2.9 (10.2)	6.2 (10.2)	6.3 (10.2)	6.5 (10.2)
REDWATER (Esso Resources)	0.8 (2.3)	0.6 (2.3)	1.1 (2.3)	1.2 (2.3)	0.9 (2.3)
ROSEVEAR (Shell)	N/O	N/O	0.8 (7.9)	1.8 (7.9)	2.2 (7.9)
ROSEVEAR (Suncor Inc.)	2.7 (5.2)	3.0 (5.2)	2.3 (5.2)	2.3 (5.2)	1.5 (4.5)
SAVANA CREEK-COLEMAN (Saratoga)	10.9 (16.3)	16.3 (16.3)	10.6 (16.3)	11.5 (16.3)	8.3 (16.3)
SIMONETTE (Shell)	4.3 (13.6)	4.5 (13.6)	3.8 (13.6)	3.8 (13.6)	3.0 (13.6)
STRACHAN (Gulf)	18.1 (29.2)	16.4 (29.2)	15.1 (29.2)	12.2 (29.2)	12.0(29.2)
STRACHAN-RAM RIVER (Canterra Energy)	75.2 (93.5)	65.0 (93.5)	62.0 (93.5)	69.4 (93.5)	52.7(93.5)
STURGEON LAKE SOUTH (Dome)	3.6 (6.2)	3.3 (6.2)	3.8 (6.2)	3.9 (6.2)	3.4 (6.2)

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TABLE 1 CONTINUED

PLANT (OPERATOR)	1977	1978	1979	1980	1981
SYLVAN LAKE (Dome)	#0.7 (1.7)	0.0 (1.7)	0.0 (1.7)	0.0 (1.7)	0.2 (1.7)
TURNER VALLEY (Western Decalta)	1.3 (3.2)	1.4 (3.2)	1.1 (3.2)	1.2 (3.2)	1.2 (3.2)
TEEPEE CREEK (Mobil -GC)	N/O	x	x 5.9 (2.6)	0.1 (2.6)	0.4 (2.6)
WATERTON (Shell)	31.2 (41.0)	33.3 (41.0)	34.1 (41.0)	25.7 (41.0)	17.9(41.0)
WEST WHITECOURT-WINDFALL (Amoco)	13.8 (25.7)	19.3 (25.7)	19.8 (25.7)	19.6 (25.7)	18.6(25.7)
WILDCAT HILLS (Petro-Canada)	8.0 (14.4)	6.9 (14.4)	7.5 (14.4)	6.1 (14.4)	4.5 (14.4)
WIMBORNE (Mobil Oil)	8.0 (16.4)	3.9 (9.7)	6.7 (9.7)	5.6 (9.7)	3.8 (9.7)
ZAMA (Dome)	3.9 (6.4)	3.6 (6.4)	4.5 (6.4)	5.6 (6.4)	1.2 (6.4)
TOTAL OBSERVED	428.5	421.6	422.2	410.8	341.6
TOTAL LICENCED	(803.6)	(797.4)	(808.1)	(793.4)	(794.9)

** -Sulphur not sulphur dioxide emission.
-In parentheses are licence values.
-All figures are based on 365 days.
-N/A - Not available; N/O - Not operated
-Observed data were taken from monthly report summaries submitted to Alberta Environment and validated with sulphur balance reports submitted to the Energy Resources Conservation Board.

\# -These values were estimated from licenced emissions using a factor of 0.44 for 1977.
The factor is a ratio of observed/licenced emission.

x -Flaring plant without sulphur recovery during this period.

TABLE 2 : SULPHUR EMISSIONS (OBSERVED VS LICENCED IN TONNES/DAY) FROM GAS PROCESSING PLANTS WITHOUT SULPHUR RECOVERY (FLARING) OPERATING IN ALBERTA FOR THE PERIOD 1977-81.**

PLANT (OPERATOR)	1977	1978	1979	1980	1981
ACHESON (I.C.G. Exploration)	0.3 (0.4)	0.4 (0.7)	0.4 (0.7)	0.4 (0.7)	0.4 (0.7)
ATHABASCA-STEEL (Dome)	N/O	N/O	0.0 (0.1)	0.1 (0.1)	0.0 (0.1)
BANTRY (Goliad)	0.0 (0.4)	#0.2 (0.4)	0.0 (0.4)	0.0 (0.4)	0.0 (0.4)
BAPTISTE LAKE-STEEL (Champlin Petroleum)	N/O	N/O	0.0 (0.3)	0.0 (0.3)	0.1 (0.3)
BIG BEND (Sulpetro)	0.2 (1.5)	0.2 (1.5)	0.2 (1.5)	0.2 (1.5)	0.2 (1.5)
BIGORAY (Amoco)	1.1 (3.0)	0.9 (3.0)	1.1 (3.0)	1.2 (3.0)	0.7 (3.0)
BLACK BUTTE (Montana Power)	0.2 (0.5)	0.1 (0.5)	0.1 (0.5)	0.1 (0.5)	0.1 (0.5)
BOUNDARY LAKE SOUTH-NEPTUNE (Golden Eagle)	0.6 (1.8)	0.8 (1.8)	1.0 (1.8)	1.0 (1.8)	0.7 (1.8)
BRAEBURN (Dome)	0.2 (0.3)	0.2 (0.3)	0.2 (0.3)	0.1 (0.3)	0.1 (0.3)
CALLING LAKE SOUTH (Suncor)	N/O	N/O	N/O	N/O	0.1 (0.2)
CAROLINE (Altana Exploration)	0.6 (0.8)	0.4 (0.8)	0.7 (0.8)	0.7 (0.8)	0.3 (0.8)

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TABLE 2 CONTINUED

PLANT (OPERATOR)	1977	1978	1979	1980	1981
CHOICE-CORONATION (Dome)	N/O	N/O	N/O	0.0 (0.2)	0.0 (0.2)
CYNTHIA (Texaco)	N/O	N/O	N/O	0.0 (1.4)	0.1 (1.4)
DUHAMEL (Mobil Oil)	N/O	N/O	0.1 (1.7)	0.7 (1.7)	0.6 (1.7)
ELK RIVER-BRAZEAU (Dome)	N/O	N/O	N/O	0.1 (3.3)	0.4 (3.3)
EMPRESS (Petro-Canada)	N/A (N/A)	N/A (0.2)	N/A (0.2)	0.0 (0.2)	0.1 (0.2)
FLORAL-BOUNDARY LAKE (Esso Resources)	N/O	N/O	N/O	0.0 (1.0)	0.2 (1.0)
FORT SASKATCHEWAN (Chevron Standard)	#0.3 (0.6)	0.0 (0.6)	0.1 (0.6)	0.2 (0.6)	0.2 (0.6)
GILBY (Petro-Canada)	N/A (0.3)	N/A (0.3)	0.1 (0.3)	0.2 (0.3)	0.1 (0.3)
GILBY-MEDICINE RIVER (Petro-Canada)	0.0 (0.2)	0.1 (0.2)	0.1 (0.2)	0.0 (0.2)	0.1 (0.2)
GILBY (Texaco)	0.1 (0.7)	0.0 (0.7)	0.1 (0.7)	0.1 (0.7)	0.0 (0.7)
GOLDEN SPIKE (Esso Resources)	0.0 (0.7)	0.1 (0.7)	0.1 (0.7)	0.1 (0.7)	0.1 (0.7)
GREENCOURT (Petro-Canada)	#2.6 (5.1)	2.3 (5.1)	3.0 (5.1)	3.0 (5.1)	2.3 (5.1)
HARMATTAN-ELKTON SOUTH (Home Oil)	0.2 (0.5)	0.1 (0.5)	0.1 (0.5)	0.1 (0.5)	0.1 (0.5)

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TABLE 2 CONTINUED

PLANT (OPERATOR)	1977	1978	1979	1980	1981
HOPE CREEK (Shell)	6.9 (9.2)	5.6 (9.2)	5.1 (9.2)	4.2 (9.2)	2.1 (9.8)
ISLAND LAKE-BAPTISTE (Dome)	N/A (0.2)	N/A (0.2)	0.0 (0.2)	0.1 (0.2)	0.0 (0.2)
JUDY CREEK (Esso Resources)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.1 (0.1)	0.1 (0.6)
KAYBOB (Petro-Canada)	N/O	N/O	N/A (5.2)	N/A (5.2)	0.9 (5.2)
KILLAM-FORESTBURG (Premier Resources)	#0.5 (1.0)	#0.5 (1.0)	0.4 (1.0)	0.5 (1.0)	0.3 (1.0)
KNOBHILL-BATTLELAKE (Texaco)	N/O	N/A (0.8)	0.0 (0.8)	0.1 (0.8)	0.0 (0.8)
LEDUC (Esso Resources)	0.8 (2.0)	0.6 (2.0)	0.7 (2.0)	0.6 (1.0)	0.9 (1.0)
LEDUC (Western Decalta)	N/O	N/A (0.6)	0.1 (0.6)	0.0 (0.6)	N/O
MARTEN HILLS (Amoco)	N/A (0.9)	N/A (0.9)	0.1 (0.9)	0.1 (0.9)	0.1 (0.9)
MEYERLAKE-BOUVIER (Dome)	N/O	0.1 (0.1)	0.1 (0.1)	0.0 (0.1)	0.1 (0.1)
OPEN CREEK (Texaco)	N/O	N/O	N/O	N/O	0.1 (0.2)
PADDLE RIVER (Canada-Cities Service)	0.6 (7.1)	0.5 (7.1)	0.6 (7.1)	0.5 (7.1)	x
PRINCESS (Chevron Standard)	0.2 (0.5)	0.2 (0.5)	0.1 (0.5)	0.1 (0.5)	0.1 (0.5)

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TABLE 2 CONTINUED

PLANT (OPERATOR)	1977	1978	1979	1980	1981
RAINBOW LAKE-EAST (Mobil Oil)	0.2 (0.3)	0.3 (0.3)	0.2 (0.5)	0.1 (0.5)	0.3 (0.5)
RED WILLOW (Husky Oil)	N/O	N/O	0.0 (0.3)	0.1 (0.3)	0.0 (0.3)
SEDGEWICK (Petro-Canada)	#0.1 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)
STROME HOLMBURG (Francana)	0.8 (4.0)	0.9 (4.0)	1.1 (3.4)	1.0 (3.4)	0.6 (3.4)
SWAN HILLS (Esso Resources)	N/O	N/O	N/O	N/O	0.0 (0.4)
TANGENT (Dome)	N/O	N/A (0.3)	0.1 (0.3)	0.2 (0.3)	0.1 (0.3)
TEEPEE CREEK (Mobil-GC)	N/O	3.1 (10.2)	x	x	x
TURIN-RETLAW (Turin Gas Plant Ltd.)	N/O	N/A (0.9)	0.3 (0.9)	0.3 (0.9)	0.4 (0.9)
VULCAN (Dome)	1.1 (5.0)	4.0 (5.0)	3.8 (5.0)	2.1 (5.0)	1.3 (5.0)
WEST PEMBINA (Chevron Standard)	N/O	N/O	N/O	N/O	0.3 (5.1)
WHITECOURT (Petro-Canada)	3.7 (7.5)	2.8 (7.5)	3.7 (7.5)	2.8 (7.5)	2.6 (7.5)
WILSON CREEK (Amerada Minerals)	1.2 (1.7)	0.8 (1.7)	1.2 (7.6)	2.2 (7.6)	1.6 (7.6)
TOTAL OBSERVED	22.5	25.2	25.0	23.4	18.9
TOTAL LICENCED	(56.4)	(69.8)	(72.7)	(77.6)	(76.9)

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TABLE 2 CONTINUED

** -Sulphur not sulphur dioxide emission.
-In parenthesis are licence values.
-All figures are based on 365 days.
-N/O - Not operated; N/A - Not available.
-Data were taken from monthly emission reports submitted to Pollution Control Division of Alberta Environment. 1977 data obtained from the Energy Resources Conservation Board.
-The list of flaring plants also includes those plants that may not flare and have emissions but no extraction process.
-Plants with licence limits of less than 0.1 tonnes per day are not included in this list.

\# -This value was estimated from licenced emission using a factor of 0.51 which is a ratio of observed/licenced emission over the entire period of 1974-78.

x -Operated with sulphur recovery (extraction) throughout this period.

TABLE 3 : OBSERVED SULPHUR EMISSIONS (TONNES/DAY) FROM SOUR OIL PRODUCTION FACILITIES (BATTERIES) OPERATING IN ALBERTA FOR THE PERIOD 1977-81.**

SOURCE	1977	1978	1979	1980	1981
SOUR OIL PRODUCTION FACILITIES	N/A	*54.7 (N/L)	#51.2 (N/L)	*45.0(N/L)	*41.0(N/L)

** - Sulphur not sulphur dioxide emission.
- All figures are based on 365 Days.
- N/A Not available; N/L - No licence required.

* - This estimate was provided by the Energy Resources Conservation Board considering 324 batteries in 1978. Since 1979, 24 sour oil pools have been included in gas conservation schemes.

- Only those facilities emitting 0.1 tonne per day or more were considered. This estimate was provided by the Energy Resources Conservation Board by averaging production data from January and July.

TABLE 4 : SULPHUR EMISSIONS (OBSERVED VS LICENCED IN TONNES/DAY) FROM OIL SANDS PLANTS OPERATING IN ALBERTA FOR THE PERIOD 1977-81.**

PLANT	1977	1978	1979	1980	1981
SUNCOR INC.					
POWER PLANT	100.1(152.4)	102.6(152.4)	103.4(152.4)	115.5(152.4)	83.0(152.4)
SULPHUR PLANT	10.3 (24.4)	8.4 (24.4)	10.4 (24.4)	13.4 (24.4)	9.6 (24.4)
SOUR GAS FLARED	1.9	1.4	1.6	2.3	6.5
SYNCRUDE CANADA LTD.					
	N/O	#35.0 (145.8)	9.4 (146)	70.5 (146)	94.5(146)
TOTAL OBSERVED	112.3	147.4	124.8	201.7	193.6
TOTAL LICENCED	(176.8)	(322.6)	(322.8)	(322.8)	(322.8)

** - Sulphur not sulphur dioxide emission.
- All figures are based on 365 days.
- In parentheses are licence values.
- Observed data were taken from monthly report summaries submitted to the Pollution Control Division of Alberta Environment.
- N/O - Not operated.

- This figure is only approximate since the plant started to operate from August, 1978.

TABLE 5 : SULPHUR EMISSIONS (OBSERVED VS LICENCED IN TONNES/DAY) FROM COAL FIRED POWER PLANTS OPERATING IN ALBERTA FOR THE PERIOD 1977-81.**

PLANT (OPERATOR)	1977	1978	1979	1980	1981
WABAMUN (Calgary Power)	6.2 (20.2)	7.6 (20.2)	12.4 (27)	21.8 (27)	15.3 (27)
SUNDANCE (Calgary Power)	20.6 (44.9)	#27.6 (66.6)	50.0 (88)	38.0 (98)	87.0(108)
BATTLE RIVER (Alberta Power)	##14.2 (31.0)	10.0 (31.0)	21.7 (31.1)	23.3 (31.1)	27.5(40.7)
H. R. MILNER GRANDE CACHE (Alberta Power)	*2.8 (4.7)^{x}	*2.8 (4.7)^{x}	4.8 (9.2)	7.1 (9.2)	6.3 (9.2)
TOTAL OBSERVED	43.8	48.0	88.9	90.2	136.1
TOTAL LICENCED	(100.8)	(122.5)	(155.3)	(165.3)	(184.9)

** - Sulphur not sulphur dioxide emission.
- All figures are based on 365 days.
- Terms in parentheses are licence values.

x - H. R. Milner licence values are based on maximum output at maximum operating level.
- Figures based on monthly material balance reports submitted to Alberta Environment.
- Wabamun plant-stack survey results in 1977-78 sulphur emissions are 14.2 & 14.7 tonnes/day respectively. Sundance plant-stack survey results in 1976-77 sulphur emissions are 20.3 & 30.5 tonnes/day respectively.

* - Figures based on a calculated operating level of 58% of rated capacity determined during stack surveys (0.25% sulphur).

- Estimates provided by the Air Quality Control Branch of the Pollution Control Division of Alberta Environment since no material balance reports available.

- 14.2 tonnes/day was estimated from the rising trend of previous reports since no material balance reports for 1977 could be found.

TABLE 6 : SULPHUR EMISSIONS (OBSERVED VS LICENCED IN TONNES/DAY) FROM REFINERIES OPERATING IN ALBERTA FOR THE PERIOD 1977-81.**

COMPANY (LOCATION)	1977	1978	1979	1980	1981
GULF CANADA PRODUCTS CO. (Edmonton)	#10.7 (12.7)	#10.7 (12.7)	#7.3 (12.7)	#5.1 (12.7)	#4.9(12.7)
ESSO PETROLEUM CANADA (Edmonton)	#7.6 (9.2)	#7.6 (9.2)	#2.2 (9.2)	#2.9 (9.2)	#2.9 (9.2)
TEXACO CANADA INC. (Edmonton)	#2.5 (6.2)	#2.5 (6.2)	#0.5 (6.2)	#0.5 (6.2)	#0.6 (6.2)
SHELL CANADA LTD. (Bowden)	#0.5 (0.4)	#0.5 (0.4)	N/A (0.4)	0.1 (0.4)	0.1 (0.4)
HUSKY OIL OPERATIONS LTD. (Loydminster)	#0.5 (No Limit)	#0.5 (No Limit)	N/A (No Limit)	N/A (No Limit)	N/A (No Limit)
GULF CANADA PRODUCTS CO. (Calgary)	---	---	N/A	#0.3 (No Limit)	#0.3 (No Limit)
TOTAL OBSERVED	21.8	21.8	10.0	8.9	8.8
TOTAL LICENCED	(28.5+)	(28.5+)	(28.5+)	(28.5+)	(28.5+)

** - Sulphur not sulphur dioxide emission.
- In parentheses are licence values.
- All figures are based on 365 days.
- N/A - Not available; N/L - No Licence.

- Estimates provided by the Air Quality Control Branch of the Pollution Control Division of Alberta Environment based on manual stack survey results.

TABLE 7 : SULPHUR EMISSIONS (OBSERVED VS LICENCED IN TONNES/DAY) FROM FERTILIZER PLANTS OPERATING IN ALBERTA FOR THE PERIOD 1977-81.**

COMPANY (LOCATION)	1977	1978	1979	1980	1981
ESSO CHEMICAL CANADA (Redwater)	0.7 (2.5)	0.7 (2.5)	1.1 (2.5)	1.1 (2.5)	1.0 (2.5)
SHERRITT GORDON MINES (Ft. Sask.)	0.2 (0.8)	0.3 (0.8)	0.3 (0.8)	0.4 (0.8)	0.2 (0.8)
INLAND CHEMICALS (Ft. Sask.)	#2.3 (2.8)	#2.3 (2.8)	1.6 (2.8)	1.6 (2.8)	1.2 (1.6)
WESTERN CO-OPERATIVE (Medicine Hat)	#5.0 (6.1)	#5.0 (6.1)	2.4 (6.1)	5.0 (6.1)	5.0 (6.1)
WESTERN CO-OPERATIVE (Calgary)	#2.0 (5.5)	#2.0 (4.9)	2.9 (4.9)	2.9 (4.9)	2.2 (4.9)
TOTAL OBSERVED	10.2	10.3	8.3	11.0	9.6
TOTAL LICENCED	(17.7)	(17.1)	(17.1)	(17.1)	(15.9)

** - Sulphur not sulphur dioxide emission.
- In parentheses are licence values.
- All figures are based on 365 days.
- N/A - Not available; N/L - No licence.
- Observed data were obtained from the percentage of sulphur content in stack flow from Alberta Environment.

- Estimates provided by the Air Quality Control Branch of Pollution Control Division of Alberta Environment based on manual stack survey results and continuous stack emission monitoring results.

TABLE 8 : SULPHUR EMISSIONS (OBSERVED VS LICENCED IN TONNES/DAY) FROM PULP & PAPER MILLS OPERATING IN ALBERTA FOR THE PERIOD 1977-81.**

COMPANY (LOCATION)	1977	1978	1979	1980	1981
ST. REGIS (Hinton)	#10.2-15.2 (N/L)	#10.2-15.2 (No Limit)	3.9 (No Limit)	3.9 (No Limit)	1.5 (No Limit)
PROCTOR & GAMBLE (Grande Prairie)	#5.1-6.1 (7.7)	#3.5 (7.7)	N/A (7.7)	5.9 (7.7)	6.6 (7.7)
TOTAL OBSERVED	21.3	18.7	3.9	9.8	8.1
TOTAL LICENCED	(7.7)	(7.7+)	(7.7+)	(7.7+)	(7.7+)

** - Sulphur not sulphur dioxide emission.
- All figures are based on 365 days.
- N/A - Not available; N/L - No licence.
- In parentheses are licence values.

- Estimates are provided by the Air Quality Control Branch of the Pollution Control Division of Alberta Environment: Test methods employed in previous years for sulphur dioxide (SO_2) and totally reduced sulphur emission data were not reliable. Future testing will employ Gas Chromatography/Mass Spectrometer Techniques and are expected to improve data accuracy considerably.

TABLE 9 : SULPHUR EMISSIONS (OBSERVED VS LICENCED IN TONNES/DAY) FROM HEAVY OIL RECOVERY PLANTS OPERATING IN ALBERTA FOR THE PERIOD 1977-81.**

PLANT (OPERATOR)	1977	1978	1979	1980	1981
ATHABASCA (Texaco)	N/O	N/O	N/A (0.6)	0.0 (0.6)	0.0 (0.5)
GREGOIRE LAKE* (Amoco)	N/O	N/O	N/A (2.6)	N/A (2.6)	N/A (2.6)
KITSCOTY (Mobil-GC)	N/O	N/O	N/O	N/A (0.4)	N/A (0.4)
MARGUERITE LAKE (BP Exploration)	N/O	N/O	N/A (6.2)	N/A (6.2)	0.9 (6.2)
LEMING (Esso Resources)	N/O	N/O	N/O	N/A (1.6)	N/A (1.6)
MAY-ETHEL (Esso Resources)	N/O	N/O	N/A (3.0)	N/A (3.0)	N/A (3.0)
PEACE RIVER (Shell)	N/O	N/O	0.0 (14.4)	3.2 (14.4)	3.0 (14.4)
PRIMROSE# (Norcen)	N/O	N/O	N/A (2.7)	N/A (2.7)	N/A (2.7)
SILVERDALE (Mobil-GC)	N/O	N/O	N/O	N/A (0.4)	N/A (0.4)
TOTAL OBSERVED	---	---	0.0	3.2	3.9
TOTAL LICENCED	---	---	(29.5)	(31.9)	(31.8)

** - Sulphur not sulphur dioxide emission.
- In parentheses are licence values.
- All figures are based on 365 days.
- N/A - Not available; N/O - Not operated.
- Observed data were obtained from reports submitted to Alberta Environment.
* - This plant has terminated operations (June/81).
# - The plant has suspended operations (December/81).

TABLE 10 : SULPHUR EMISSIONS (OBSERVED VS LICENCED IN TONNES/DAY) FROM OTHER INDUSTRIAL SOURCES OPERATING IN ALBERTA FOR THE PERIOD 1977-81.**

COMPANY (LOCATION)	1977	1978	1979	1980	1981
ALCAN (Edmonton)	*6.8 (5.9)	*5.2 (5.9)	N/A (5.9)	3.1 (5.9)	4.6 (5.9)
THIO-PET CHEMICALS (Ft. Sask.)	3.2 (1.0)	0.8 (1.0)	0.6 (1.0)	0.6 (1.0)	0.5 (1.0)
TOTAL OBSERVED	10.0	6.0	0.6	3.7	5.1
TOTAL LICENCED	(6.9)	(6.9)	(6.9)	(6.9)	(6.9)

** - Sulphur not sulphur dioxide emission.
- All figures are based on 365 days.
- In parentheses are licence values.
- N/L - No licence; N/A - Not available.

* - Observed data of quantities of green and calcined coke and their sulphur content were obtained from Alcan.
- These estimated values are under review by the Air Quality Control Branch of Alberta Environment.

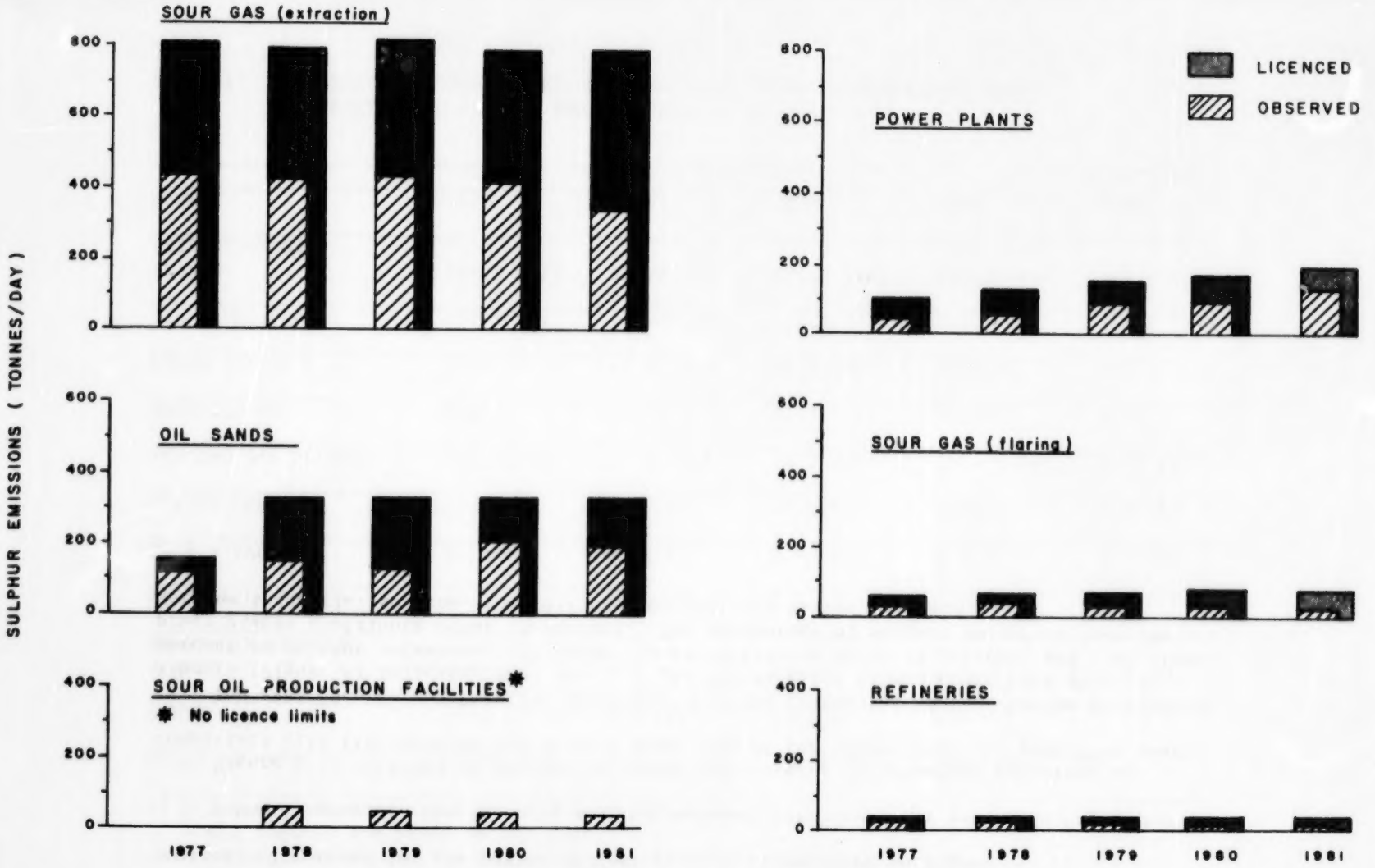

FIGURE 1: COMPARISON OF OBSERVED VERSUS LICENCED SULPHUR EMISSIONS FROM SPECIFIC INDUSTRIES FOR THE PERIOD 1977 - 1981

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III. INDUSTRIAL SULPHUR EMISSION INVENTORY (1977-81)

This section provides trends of total sulphur emissions (observed and licenced) from industrial categories operating in Alberta on a year to year basis for the period 1977-81.

Table 11 lists the observed (actual) sulphur emissions from the various industrial sources. The trend for the period 1977-81 is also illustrated in Figure 2.

Table 12 provides the licenced sulphur emission breakdowns for each industry category.

Figure 3 is included to provide an overall picture of the observed emissions in comparison with the licenced and to give some idea of the trends over the past five years.

The 1981 "Source and Emission Inventory" for the industrial sources in the province of Alberta (Figure 4) indicates that the sour gas (extraction) plants contribute about 47 percent of sulphur emissions, oil sands plants contribute about 25 percent, and coal fired power plants contribute about 18 percent. The percentage of sulphur emissions from the various industrial sources from 1977 through 1981 are listed in Table 4.

TABLE 11 : OBSERVED SULPHUR EMISSION (TONNES/DAY) FROM INDUSTRIAL SOURCES OPERATING IN ALBERTA FOR THE PERIOD 1977-81.**

SOURCE	1977	1978	1979	1980	1981
EXTRACTION GAS PLANTS	428.5 (42)	421.6 (42)	422.2 (44)	410.8 (45)	341.6(46)
OIL SANDS PLANTS	112.3 (1)	147.4 (2)	124.8 (2)	201.7 (2)	193.6 (2)
POWER PLANTS	43.8 (4)	48.0 (4)	88.9 (4)	90.2 (4)	136.1 (4)
SOUR OIL PROD. FAC.	N/A	54.7	51.2	45.0	41.0
FLARING GAS PLANTS	22.5 (28)	25.2 (36)	25.0 (40)	23.4 (44)	18.9 (46)
REFINERIES	21.8 (5)	21.8 (5)	10.0 (3)	8.9 (5)	8.8 (5)
PULP & PAPER	21.3 (2)	18.7 (2)	3.9 (1)	9.8 (2)	8.1 (2)
FERTILIZER PLANTS	10.2 (5)	10.3 (5)	8.3 (5)	11.0 (5)	9.6 (5)
HEAVY OIL RECOVERY PLANTS	---	---	---	3.2 (1)	3.9 (2)
OTHER	10.0 (2)	6.0 (2)	0.6 (1)	3.7 (2)	5.1 (2)
TOTAL OBSERVED	670.4 (89)	#753.7 (98)	734.9 (100)	807.7(110)	766.7(114)

** - Sulphur emission not sulphur dioxide emission.
- All figures are based on 365 days.
- In parentheses are the number of plants contributing daily output.
- N/A - Not available.
- Total emissions for 1978 fall out of line with the established trend due to inclusion of battery emissions in 1973.

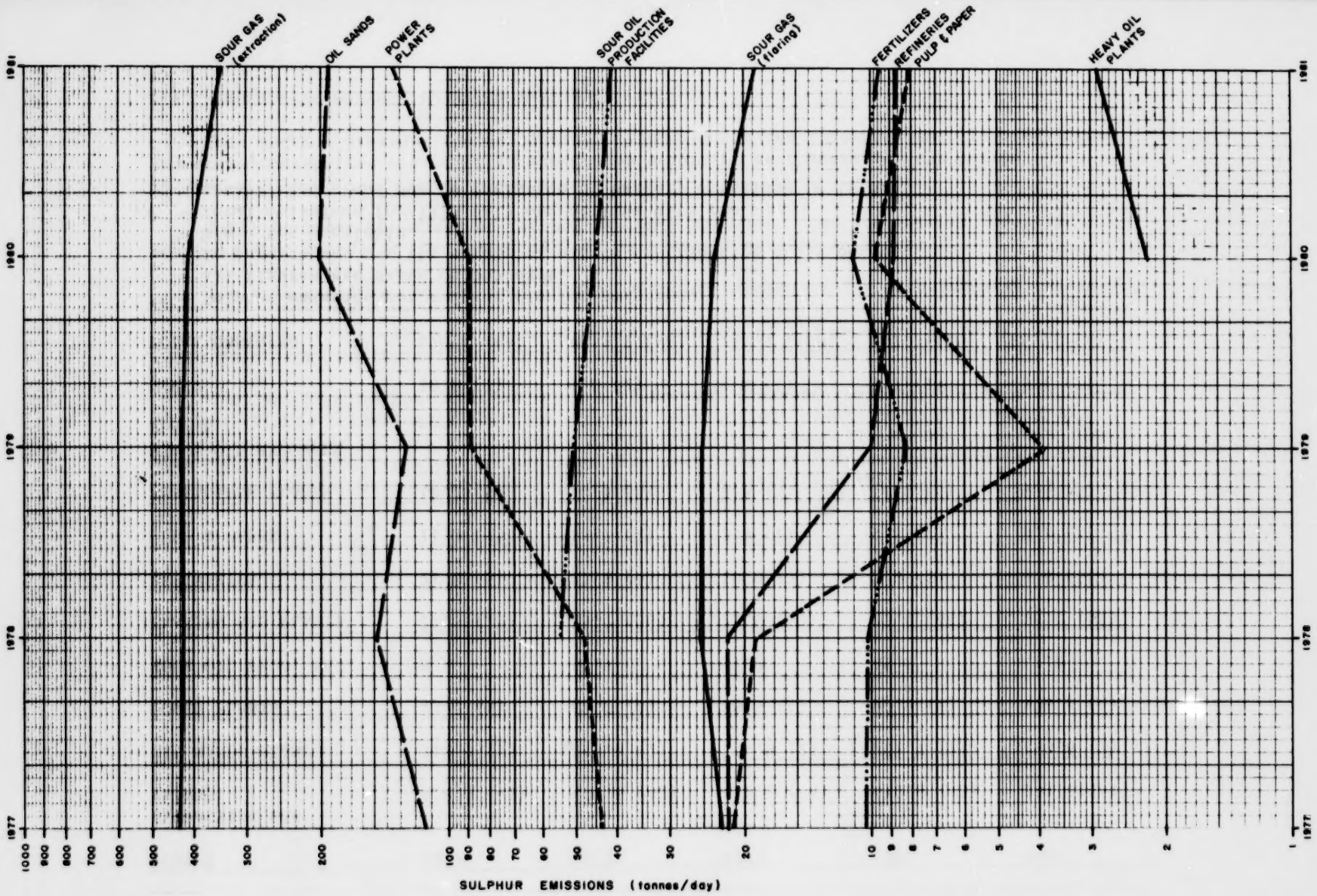

FIGURE 2 : OBSERVED SULPHUR EMISSIONS FROM INDUSTRIAL SOURCES OPERATING IN ALBERTA FOR THE PERIOD 1977-81.

Alberta ENVIRONMENT Pollution Control Division

TABLE 12 : LICENCED SULPHUR EMISSIONS (TONNES/DAY) FROM INDUSTRIAL SOURCES OPERATING IN ALBERTA FOR THE PERIOD 1977-81.**

SOURCE	1977	1978	1979	1980	1981
EXTRACTION GAS PLANTS	803.6 (42)	797.4 (42)	808.1 (44)	793.4 (45)	794.9 (46)
OIL SANDS PLANTS	176.8 (1)	322.6 (2)	322.8 (2)	322.8 (2)	322.8 (2)
SOUR OIL PROD. FAC.	N/L	N/L	N/L	N/L	N/L
POWER PLANTS	100.8 (4)	122.5 (4)	155.3 (4)	165.3 (4)	184.9(4)
FLARING GAS PLANTS	56.4 (28)	69.8 (36)	72.7 (40)	77.6 (44)	76.9 (46)
REFINERIES	28.5+ (5)	28.5+ (5)	28.5+ (5)	28.5+ (6)	28.5+ (6)
PULP & PAPER	7.7 (2)	7.7+ (2)	7.7+ (2)	7.7+ (2)	7.7+ (2)
FERTILIZER PLANTS	17.7 (5)	17.1 (5)	17.1 (5)	17.1 (5)	15.9 (5)
HEAVY OIL RECOVERY PLANTS	---	---	29.5 (6)	31.9 (9)	31.8 (9)
OTHER	6.9 (2)	6.9 (2)	6.9 (2)	6.9 (2)	6.9 (2)
TOTAL LICENCED	1198.4+ (89)	1372.5+ (98)	1448.6 (110)	1451.2(119)	1470.3(122)

** - Sulphur(S) not sulphur dioxide (SO_2) emission.
- In parentheses are the number of plants.
- All figures are based on 365 days.
- N/L - No licence.

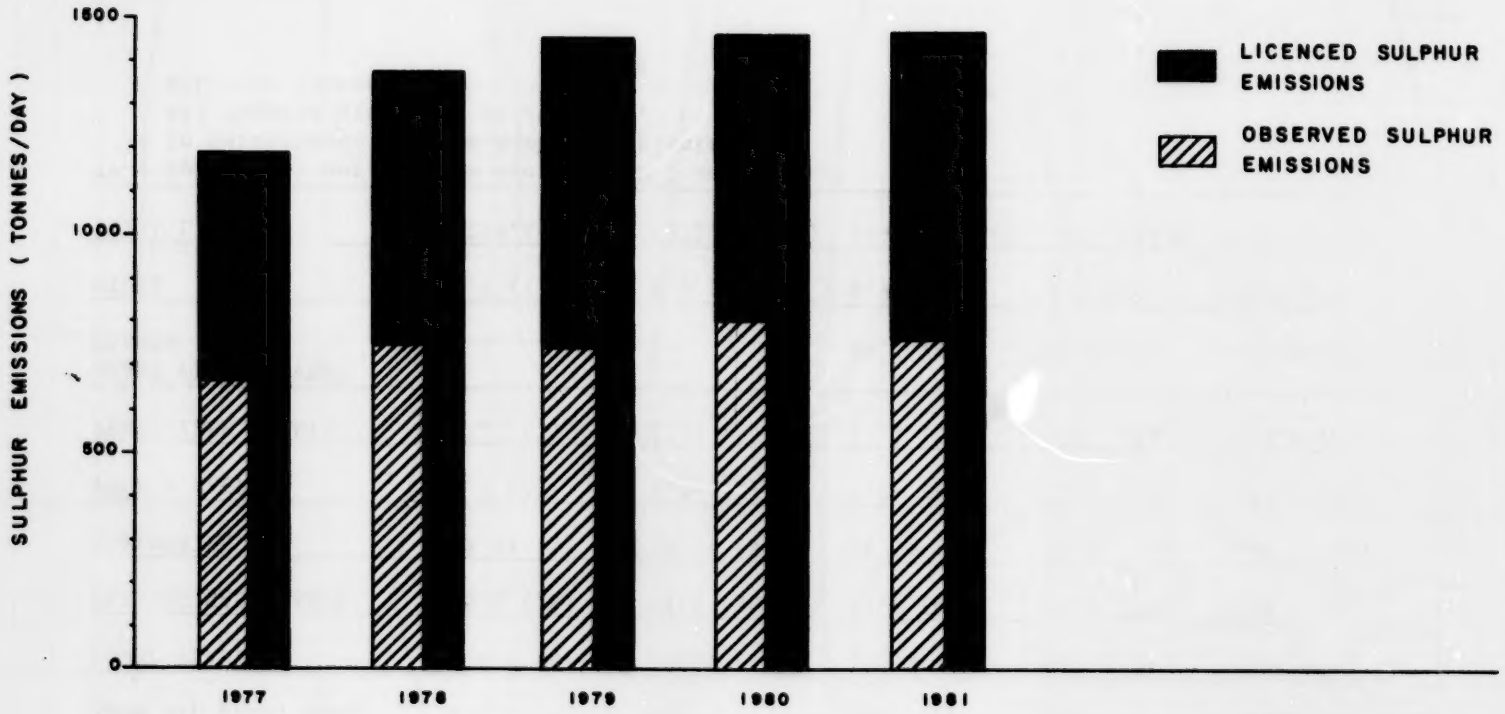

FIGURE 3: COMPARISON OF TOTAL OBSERVED VERSUS LICENCED SULPHUR EMISSIONS FROM INDUSTRIAL SOURCES FOR THE PERIOD 1977 - 1981

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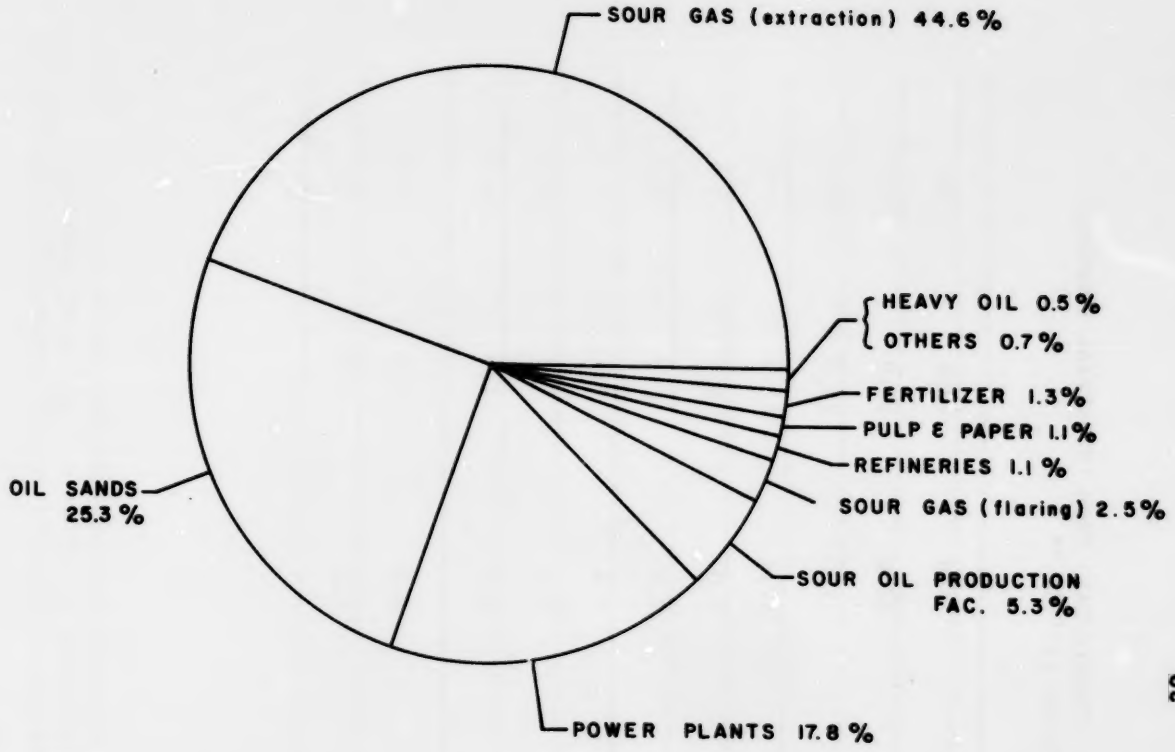

RELATIVE CONTRIBUTION OF EACH INDUSTRY TO TOTAL SULPHUR DIOXIDE EMISSIONS (expressed as sulphur) IN ALBERTA IN 1981

SULPHUR

279,800 TONNES

FIGURE 4: SULPHUR SOURCE AND EMISSION INVENTORY FOR 1981

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TABLE 13 : PERCENTAGE OF SULPHUR EMISSIONS (TONNES/DAY) FROM INDUSTRIAL SOURCES OPERATING IN ALBERTA FOR THE PERIOD 1977-81.**

SOURCE	1977	1978	1979	1980	1981
EXTRACTION GAS PLANTS	63.9	55.9	57.4	50.9	44.6
OIL SANDS PLANTS	16.8	19.6	17.0	25.0	25.3
POWER PLANTS	6.5	6.4	12.1	11.2	17.8
SOUR OIL PROD. FAC.	N/A	7.3	7.0	5.6	5.3
FLARING GAS PLANTS	3.4	3.3	3.4	2.9	2.5
REFINERIES	3.3	2.9	1.4	1.1	1.1
PULP & PAPER	3.2	2.5	0.5	1.2	1.1
FERTILIZER PLANTS	1.5	1.4	1.1	1.4	1.3
HEAVY OIL RECOVERY PLANTS	0.0	0.0	0.0	0.4	0.5
OTHER	1.5	0.8	0.1	0.5	0.7

** - Sulphur not sulphur dioxide emission.
- N/A - Not available.

IV. INDUSTRIAL SULPHUR EMISSION TREND (1974-81)

The general trend of sulphur emissions from industrial sources operating in Alberta for the period 1974 through to 1981 is represented in Figure 5. The total observed emissions are compared with the licenced emissions on a year-to-year basis.

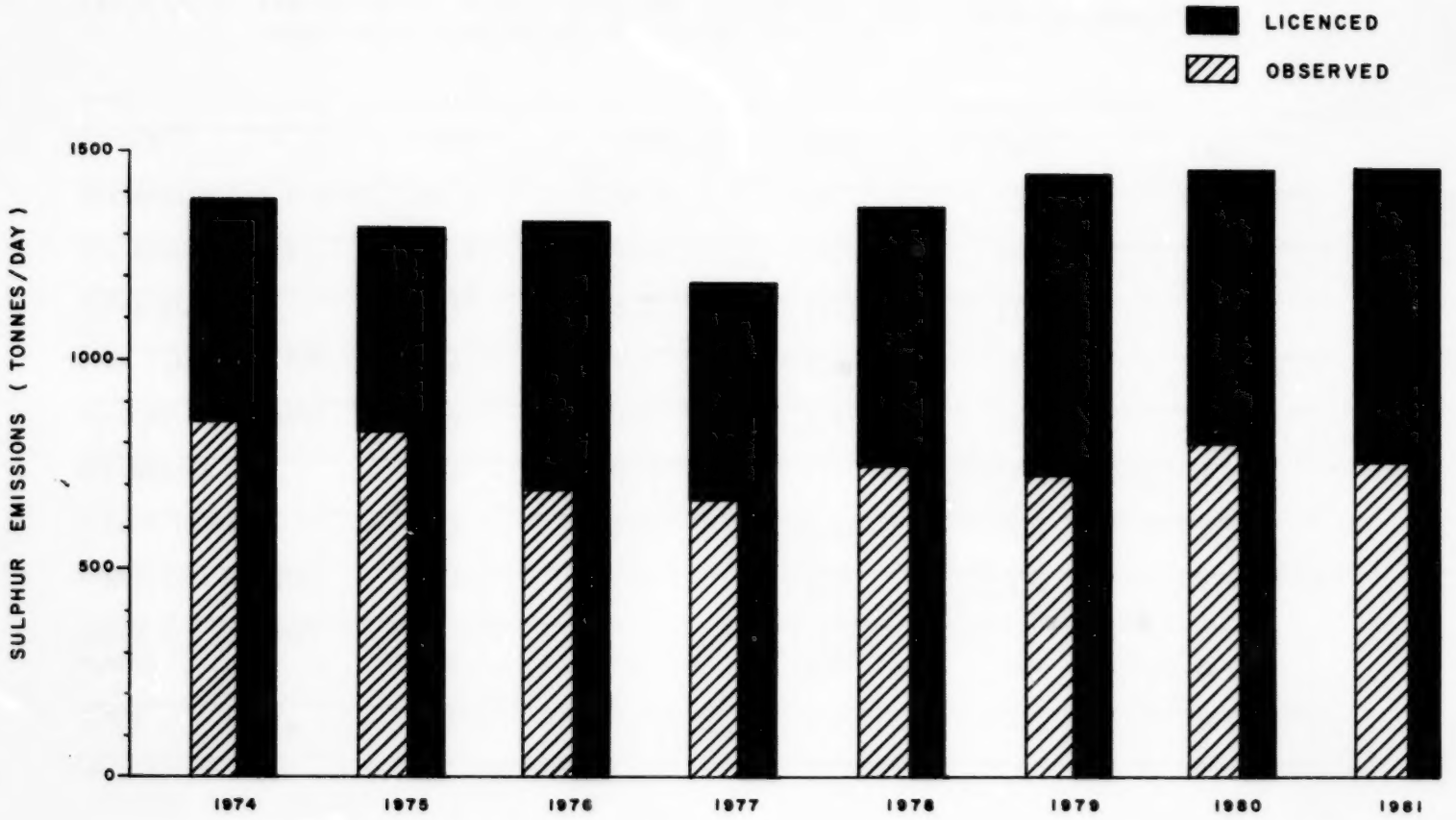

FIGURE 5: TRENDS OF TOTAL OBSERVED VERSUS LICENCED SULPHUR EMISSIONS FROM INDUSTRIAL SOURCES FOR THE PERIOD 1974 - 1981